

Analysis of radio field requirement for RFID systems use in warehouses

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Abstract: RFID systems work on communication between data carriers and data readers. This basic data transmission is provided in virtual network, which have to be steady. Reading range of data readers is depending on many factors, as devices parameters, surroundings and type of data carrier. Nowadays technology provides better communication between devices, which dramatically increases distance, in which devices are able to communicate with each other. With proper setting, interaction in logistic processes could be faster and stable. This paper explores equipment needed for transport information from data carrier through data readers to software devices, which are responsible for information processing.

Keywords: AIDC, RFID, Wi-Fi.

1. Introduction

Nowadays are AIDC systems daily used in lot of variants: Barcodes in groceries, because of very low cost, RFID systems for tracking in time and space (for examples material by shipping and animals in nature to have better overview about species representation).

On Figure 1 are described basic components of RFID systems. RFID antenna sends signal to data carrier (RFID tag), which send data back to RFID reader (through RFID antenna). Reader provides data to software for further analysis.

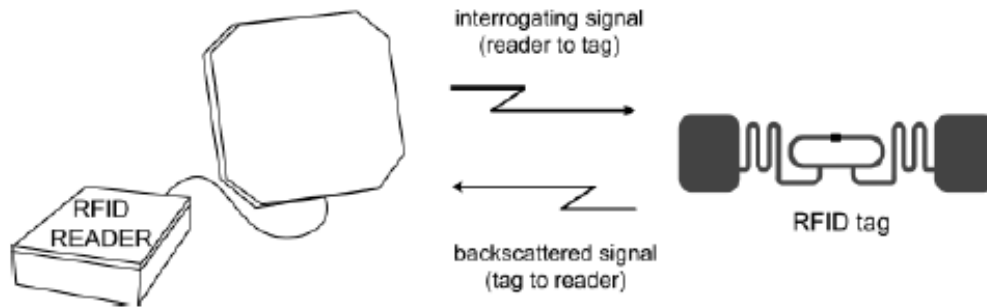


Figure 1: Overview of AIDC systems Source: [9]

Barcode system could be explained in very similar way. For reading data from data carrier (Barcode) is used scanner. This scanner needs to be connected to software, which can analyze data contained in BarCode. This connection is mostly done by Wireless technology, especially by Wi-Fi connection.

2. Wi-Fi

Wi-Fi is a technology, which allows electronic device (smart phones, laptops, etc.) connect to wireless network. After connecting to wireless local area network (WLAN) these devices can use benefits of the network, like connection to internet, Ethernet or information stored on other device. However, all communication goes through Wi-Fi, which could take some time for information processing and sending it further.

Wi-Fi is very useful for mobile devices, which can sign to local network without cable connection. Because of the possibility of usage secret data, Wi-Fi technology is protected by various security systems.

2.1 Functioning overview

As mentioned before, for working in Wi-Fi network area similar equipment is requested like for technology RFID. Every device defined for working in wireless network has to be assigned to specific antenna for further communication with system.

Concrete working overview of Wi-Fi systems is described on figure 2.

On figure 2 main components of Wi-Fi are these:

- Mobile devices – every single device, which moves in Wi-Fi range and it's capable of joining to this Wi-Fi. (Notebook, PC, smartphones, mobile terminals, etc.)
- Antenna (often known as Access point) – it's a place through which information flows from mobile device to the system and back.
- Software background (connected to wired LAN) – Combination of every hardware and software equipment capable of processing information incoming from mobile device.

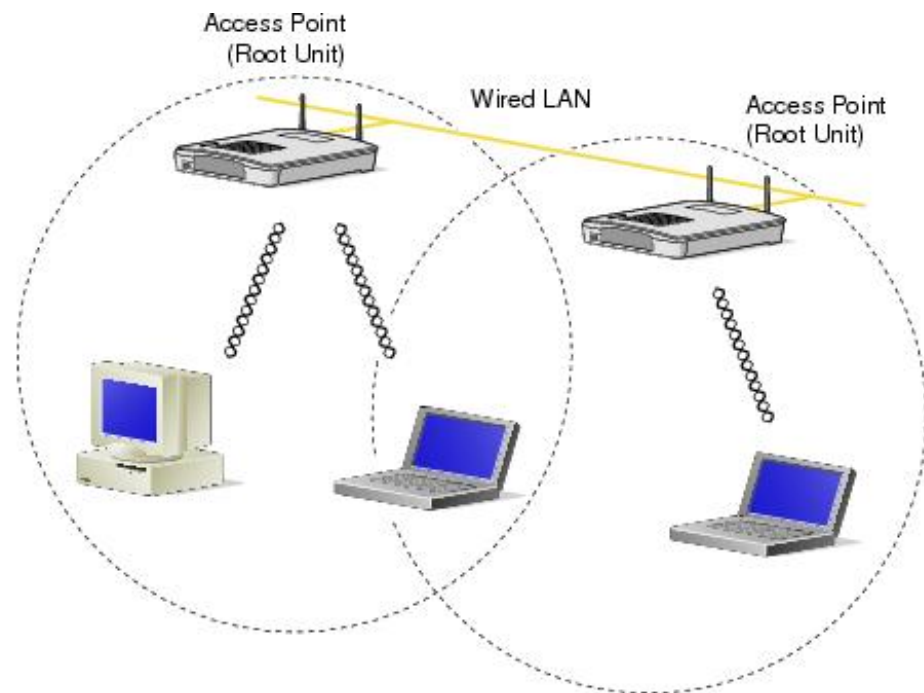


Figure 2: Overview of Wi-Fi system Source: [3]

It is necessary to cover large area with Wi-Fi signal for common usage in production companies. One Access Point (=AP) is not enough to provide signal for many devices because of small covering range, so a series of AP's (antennas) capable of managing more than one mobile device in time is needed.

In common usage, device is not defined to concrete AP, but is targeting specific one selected by the most important indicators: strength of Wi-Fi signal. Device will joint to software background through the AP, which guarantees the best communication (= AP with the strongest signal). Because of connection-stability reason, mobile devices are often set to be "faithful" – device will be connected to AP as long as strength of signal doesn't drop until stated level.

In some extra setting is possible for devices to communicate with each other directly, if they are in Wireless network. That means, information doesn't flow from one device to other via AP and software background, but directly to other devices. These devices are known as P2P devices. According to Camps-Mur 2013 [2], Wi-Fi technology provides new possibilities of communication between devices. Even nowadays, research of Wi-Fi P2P technology could bring another view on Wi-Fi theory. Similar estimation has Lim (2013) [8]

2.2 RFID coverage of Warehouse

As mentioned above, every single access point has defined operating range, in which could every device be recognized. This operating range is depending mostly on type of Antenna (its quality and properties) and area, to which wired network is planned. In case of warehouse: it's a big difference, if warehouse is empty, or full. Next important aspect in full warehouse is: composition of material, which is stored in storeroom. Wi-Fi signal has different behavior in area crowded with paper, wood, plastic or metal.

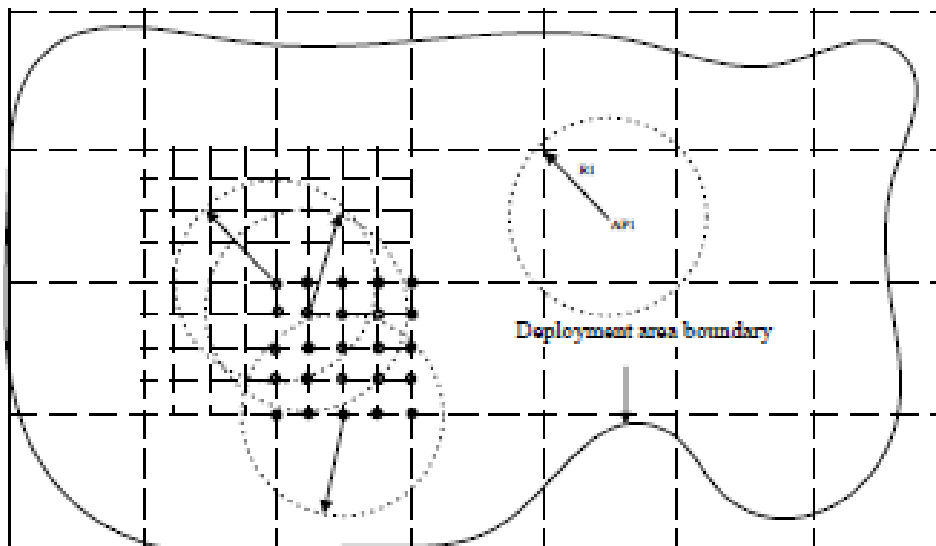


Figure 3: Principle of signal covering in Warehouse Source: [1]

Basically in every area with optimal settings, signal have optimal range, in which is working properly. With increasing distance from AP, Wi-Fi signal become slower. For better warehouse coverage multiple AP's has to be used. Cooperation between AP's is showed on figure 3.

2.3 Communication in Wi-Fi network

As described above, Wi-Fi system requested antennas for emitting and receiving signal and information. From definition of RFID (FINKENZELLER 2010 [4]), RFID system always contains module form receiving and transmitting radio-frequencies, which are basic recourse for communication in RFID systems.

Nowadays progress in RFID technologies provides possibility to use Wi-Fi antennas for this communication. According to Camps-Mur 2013 [2], Wi-Fi P2P (= peer to peer) devices can communicate with each other as long, as they are in wireless network. With special AP-like implementation, these devices could be used as new "antennas" for further signal spreading. This setting is described on figure 4.

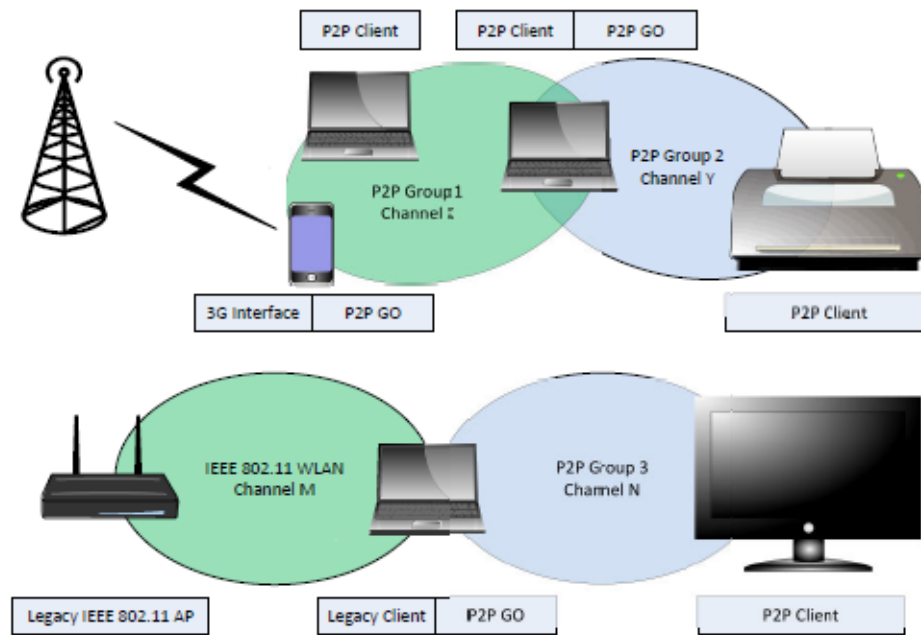


Figure 4: Example of P2P direct connection Source: [2]

For these setting is important to group devices together, so this group has basically the same functionality as common device. If there is some device with AP-like functionality in group, this device (known as P2P Group owner – P2P GO) is acting as AP for another group of devices. This secondary AP providing Wi-Fi is named P2P Client (according to Kang 2014) [7].

With P2P connection between devices is possible to spread WI-FI signal with better quality to place, where it's difficult to achieve requested strength of WI-FI, which means better coverage of warehouse. Moreover: in case, that devices are able to communicate with each other directly (=not through Wi-Fi), data processing and respond are faster.

3. AIDC

Automatic identification and data capture is nowadays very common element defined for fast information collection from Society. For most usual systems belongs BarCode reading technology (both, 1-D and 2-D) and RFID technology

3.1 Real Usage of RFID

As described above: Radio-Frequency Identification technology required system of RFID tags - data carriers, and RFID readers – devices capable of reading information from tag.

There are two basic ways of extraction information from RFID tag: static and dynamic. Static way is supposed to reading tags, which go through static gate. The goal is to read every single tag which is going through at least once and read requested data (for example tag ID). Dynamic way means going with mobile RFID reader directly to tag and read information from only this one tag.

3.2 Wi-Fi in RFID processes

Mobile devices working in Wi-Fi area could be as well devices intended for AIDC processes.

One example for all: mobile terminal for BarCode reading. It is theoretically possible to work without any intranet access, but unfortunately information read from BarCode can't be utilize without software background, which are denoted as EIS – enterprise information systems (SAP, SYSPRO, etc.)

Wi-Fi technology is used for communication with EIS. Mobile RFID terminals are working in the same principle. Information received from RFID tag is send to EIS through AP. After processing information income, EIS send back to RFID scanner order, which operations are planed with material assigned to this tag.

Concrete overview of communication between RFID and EIS systems is described on figure 5.

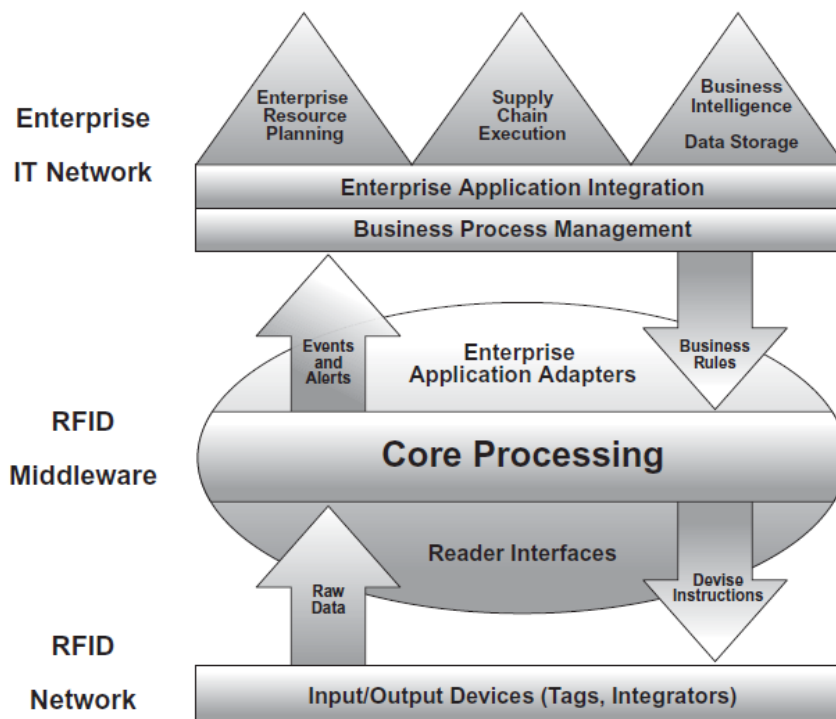


Figure 5: Communication between RFID and EIS systems Source: [6]

On figure 5 is visible flow of information from RFID tag's through "core processing" which could be RFID scanner after reading tag. This scanner provides information through IT network to EIS, where the information is evaluated. After this data processing RFID scanner receive information (order) about tag. It is important, that this whole information flow can't take more than couple of seconds.

4. Cooperation between RFID and Wi-Fi direct connection

RFID systems needs software background to interpret data from RFID tags. Wi-Fi network is requested for connection to EIS. What will happen, if RFID systems will be using Device-to-Device direct connection?

In large halls, where thousands and thousands of goods (tags including) are stored and moved, exact RFID tag identification is needed. For this reason it is necessary to have as precise systems as possible.

With cooperation of RFID and P2P systems, more accurate information about RFID tags movement EIS system will have. Basic picture of interaction is explained below:

For presumption: material is stored in flow-rack, where are two RFID gates. One serves for registering all tags (and therefore materials) for its track, so the EIS could be sure that the material is on right place. Second gate is defined for monitoring outgoing tags. Both gates will work as Group owner and every single tag will be client of this group from moment it's read in first gate to the moment of reading in second gate. With this P2P extension any not-standard movement, described in figure 6 like fallout of material through flow rack or picking it in undesirable way, could be detected in very short time.

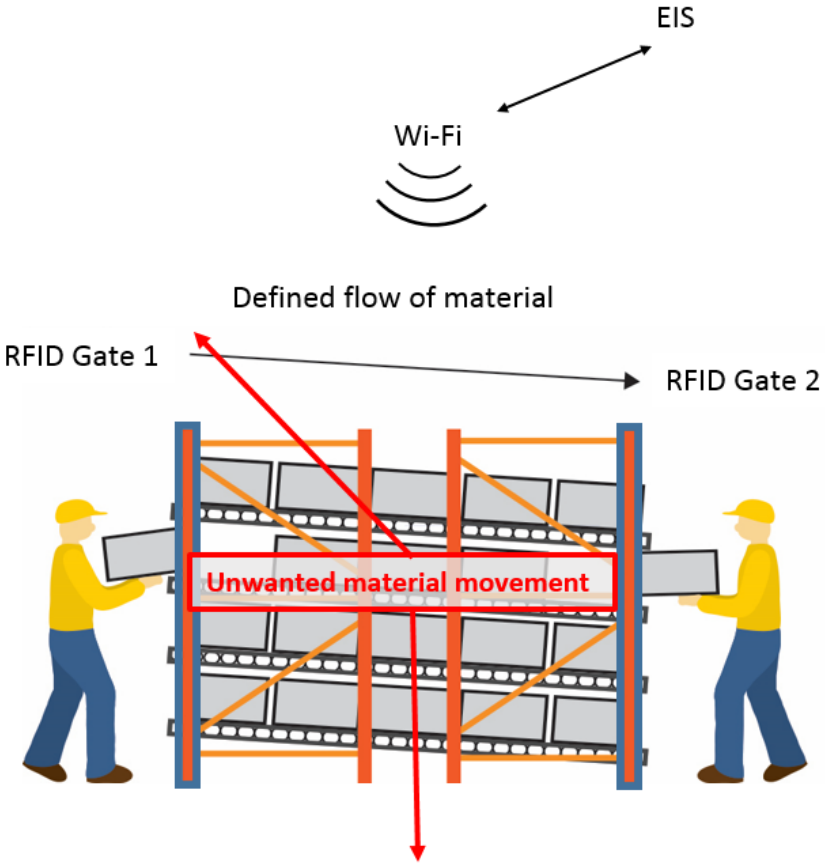


Figure 6: RFID and P2P interaction Source: authors

Additionally for the interaction with Pick-up by light technology special color signal could be defined. Through this signal EIS will immediately alert personal near this flow rack, so the solution could be even faster,

Another possibility to use P2P system with Pick-up by light technology is with the fixed shipping plan. In case, it is precisely defined in EIS, which tags (= materials) have to be picked in requested time slot, all these tags could be assigned to mobile RFID reader like P2P clients. With this interaction wrong tag couldn't be picked.

5. Conclusion

Usage of RFID technology is growing rapidly nowadays. These systems increase overview of material movement as well as operational efficiency.

In a classical way, every single RFID device (RFID tags including) have to be assigned to EIS directly through Wi-Fi connection. This paper brings new possibility of RFID communication with the EIS. In case of large warehouse with flow of thousands of pallets, monitoring all of the RFID devices in real time will require very sophisticated system, which could be expensive. In cooperation with P2P direct connection, EIS could work more precisely with quicker respond to target device because of less data processing.

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